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THE Biologist

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On the Theory of Preformation— An Eighteenth Century Enigma

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FROM THE MIDDLE of the seventeenth century to the end of the eighteenth the history of biology is an interesting study of contrasts. The period represents a unique time in the history of science—an emergence from the old ideas and a preparation for the new. The Baconian precepts for experimental science lit the way for the work of Harvey, and the invention of the microscope gave the biologist a new tool with which to study a heretofore undreamed of universe. Man was, however, still close to the medieval ways of thought, the rediscovery of the learning of antiquity, and the all-pervading theologic doctrines of the times. It is not surprising, therefore, that men of science were inconsistent in the fruits that were produced by their labors. Rationalism and religion often gained the upper hand over empiricism and experimentalism, usually to the detriment of the advancement of knowledge.

The biologists of this period were busy with many tasks. The extension of the geographic knowledge of the Western world led to the discovery of countless species of new organisms; to bring order out of chaos new classification schemes were being devised. Descriptive anatomy, both gross and microscopic, was developing into a new science. The basis for physiology and embryology was founded by the work of Harvey, Malpighi, von Haller, Wolff, and others. Philosophically the mechanistic approach of Descartes, de la Mettrie, and Locke was causing new thinking and new study of life phenomena. Determinism, vitalism, mechanism and other concepts of the nature of the universe and of nature itself gave impetus to the study of man's place in the scheme of things. Theories of origin, development, and nature of life were being formed. Three problems were of particular importance to this period, and the various solutions put forth on these problems had much to do with the development of nineteenth century and even present-day biology. These three problems of the eighteenth century biologist were abiogenesis versus biogenesis, epigenesis versus preformation, and vitalism versus mechanism.

It will be the purpose of this article to follow one aspect of this great intellectual struggle and to develop some of the ramifications of man's idea of nature in the eighteenth century by presenting the theory of preformation, a concept that for nearly a century clouded the vision of scientists and delayed embryological investigation for at least half that period.

The doctrine of preformation (also called *emboitement*, *Einschatelung*, or *encasement*), as it was developed in the latter half of the seventeenth century, held that all things that have ever lived or shall live are preformed and pre-existing in miniature from the time of creation. Bizarre as this idea may seem today it was then accepted in several modified forms by most of the leading biologists and theologians of the period. It was not a new idea but one that can be traced to ancient times. A closer look at the teachings of antiquity on this subject, in addition to the later philosophical basis for the theory, should aid in understanding its reconception and exposition, as well as its acceptance over a period dating from about 1675 A.D. to 1775 A.D.

As with so many other scientific disciplines, the beginning of embryology as a science traces back to Aristotle. It is true that the ancient Egyptian, Hindu, and Hebrew cultures had produced speculation on the nature of the generation and development of organisms, and the philosophic schemes of Empedocles, Epicurus, and Plato all theorized on certain aspects of the subject. It still seems, however, that Aristotle's work, *De Generatione Animalium*, represents the true founding of embryology. In this great work the philosopher discusses the nature of sex, the role of the sexes in generation, and the nature of the development of the embryo. It is to this work, therefore, that we turn for the first clear statement of our problem. In book II, included in the chapter on the embryological classification of animals (which is one of Aristotle's crowning biological achievements), is a piercing discussion of epigenesis and preformation. Aristotle was the first to perceive the antithetical nature of these two concepts, and as will subsequently be seen, this problem was not settled until the end of the eighteenth century. As Aristotle poses the question two alternatives seem to exist: (1) embryonic development is a fresh development of new structures by the developing egg, or (2) it is a simple unfolding or swelling of pre-existent structures. As is so often the case there seems to be a bit of the truth in each alternative and so the battle lines were formed. Aristotle himself seemed to favor epigenesis in holding that the future individual is only potentially present in the germ.

From the time of Aristotle to the middle of the seventeenth century there

was much conjecture on the problem but little in the way of scientific work was done. Since this problem of epigenesis versus preformation came to play a central role in the history of embryology it might be interesting to note the nature of some of the early work in this field, which provided the basis for the ideas of ancient and medieval men on the development of the embryo.

Fundamental and certainly of earlier importance than the idea of the development of the embryo is the concept of how new living things are first generated. The myths and legends of antiquity as well as the customs and taboos of contemporary primitive peoples shed some light on the early concepts of generation. In most instances these less sophisticated peoples failed to realize the true nature of sexuality in either plants or animals, and the mechanisms by which reproduction took place were most often thought to be controlled by magic and various supernatural powers. Fertility rites, pre-marriage sexual customs, and agricultural practices show that many erroneous ideas were held by these early peoples. Where the nature of sexuality was suspected it was usually subverted by the social ideas of the group. The role of the male and that of the female were conjectured not to fit the facts but instead to show the supremacy of one sex or the other, or to fit certain religious ideas.

Once again we can turn to Aristotle for a summary of the most pertinent ideas of ancient times on the nature of generation. The male of the species contributed the form while the female contributed the substance. This idea with various modifications influenced much of later thought, not only biological but theological and legal as well.

Of the development of the individual in the embryonic state most of the early knowledge was gained from the study of the development of the chick in the egg. The Egyptians had early developed incubators for artificial hatching of eggs and it is known that study of the embryonic development of the chick was carried on in early times. The Hippocratic school on the island of Cos carried out studies on foetal development as early as the sixth century B.C. Plato wrote little on embryology but Plutarch says, "Plato directly pronounceth that the foetus is a living creature, for that it moveth and is fed within the bellie of the mother." As has been said before, Aristotle truly stands forth as the father of embryology and his writings show that he, too, worked with the developing chick. Aristotle worked with many other animals and also with plants although he failed to recognize the sexual nature of plants. After Aristotle, scientific work moved to Alexandria where much new information was gained through dissection. The Alexandrian school introduced Greek biology into Rome. Needham, in his

History of Embryology, relates an interesting, if true, example of experiment in Alexandrian times. The story is that Cleopatra, the Ptolemaic queen, had investigated the process of foetal development by the dissection of slaves at known intervals of time from conception, following the precepts of Hippocrates with regard to hen's eggs. On the authority of this Alexandrian experiment it was taught that the male foetus was complete in forty-one days and the female foetus in eighty-one days. Sceptics pointed out that copulation might have taken place before the experiment began or that intercourse might have occurred between prison guards and the slaves, but the experimenters replied that the controls had been rigid. We shall see how later theological implications of this "perfection" time of the embryo placed great emphasis on some of these early questionable embryological experiments.

With the passing of Galen and the eclipse of the Roman Empire scientific embryology went into decline and most embryonic speculation was of a theologic nature. There can be no doubt that theologic embryology has had no slight influence on scientific thought along embryonic lines.

With the development of the knowledge of embryology certain problems of a religious nature arose. In earliest times it was thought that at birth the soul was received. Later, however, it became of utmost importance that the problem of development of soul and of life be studied so that theology might take a definite stand on the question. The problem was this: At what point does the immortal constituent universally regarded as existing in living beings take up its residence in the embryo? These considerations came to carry great weight for without some stand no moral status could be assigned to abortion, it could not be ascertained as to when baptism would be required, nor could the very nature of the soul itself be completely known. From the early enquiries of the Church into this subject there has grown a large wealth of dogma and doctrine to guide the faithful.

In the second century A.D. the patristic Father Tertullian wrote that the soul was present fully in the embryo throughout its intrauterine life. "Reply," he says, "O ye mothers, and say whether you do not feel the movements of the child within you. How then can it have no soul?" Another of the Fathers, St. Augustine of Hippo, said he thought that instead the embryo was "besouled" in the second month and "besexed" in the fourth. These ideas were soon duly reflected in the laws concerning abortion and infanticide. In 692 the Bishops of the Quinisext Council said, "And we pay no attention to the subtle distinction as to whether the foetus is formed or unformed." This had implications concerning birth control as well as abortion. Other modifications were made and the canonized law

finally came to place the soul in the embryo at the fortieth day for both sexes. The "embryo informatus" thus had no soul, the "embryo formatus" did have and as such could be baptized. St. Thomas Aquinas was of the opinion that embryos dying "in utero" could be baptized and thus saved, others doubted it.

In the twelfth century, St. Hildegard described her act of seeing the soul enter the embryo and substantiated "in fact" earlier ideas concerning this phenomenon. Later the Scholastics considered the ideas of the earlier Church fathers and consolidated the position of the Church. Earlier views had run along three lines, however not to equal extent in all three cases. These ideas were pre-existence, creationism, and traducianism. Pre-existence taught that all human souls were created at the beginning, before the creation of matter. They simply took up their residence in the embryo as these were made ready. This view that souls were created of old by God and kept in a treasury fell into disfavor after the fourth century. Creationism taught that at some point during development a new soul is created "de nihilo" by God and infused into the embryo. The body, on the other hand, derives from Adam by propagation. In this scheme an infinite number of soul creations is necessary but only one creation suffices for the body. Traducianism taught that both souls and bodies were derived from Adam, so that in generation both parts of man are derived from his parents. Of these doctrines creationism prevailed until the time of the Reformation when the Catholic Church returned to Augustinianism and thus traducianism.

The idea of traducianism was compatible with the theory of preformation. In fact the idea of original sin is easily explainable on the preformation basis. When Adam and Eve sinned all humanity sinned since all humanity, souls and substance, was there—preformed in the ovary of Eve.

One of the more pressing problems with which theologic embryologists had to contend is illustrated in the following anecdote:

"I write to you to ask your reverence what opinion you hold concerning one who on a Friday should eat an egg with a chicken in it. For you must know that we were lately sitting in an inn in the Campo dei Fiori, having our supper, and were eating eggs, when on opening one I saw that there was a young chicken within. This I showed to a comrade, whereupon quoth he to me, 'Eat it up speedily, ere the taverner see it, for if he mark it, you will have to pay for a fowl. It is a rule of the house that once the landlord has put anything on the table, you must pay for it, he wont take it back.' In a trice I gobbled down the egg, chicken and all, and then I remembered it was Friday. So I said to my companion, 'You have made me commit a mortal sin in eating flesh on the sixth day of the week.'

But he averred it was no mortal sin, nor even a venial one, seeing that such a chick as accounted an egg merely, until it is born. He told me, too, that it is just the same in the case of cheese, in which there are sometimes mites, as there are maggots in cherries, peas, or new beans; yet all these may be eaten on Fridays and even on Apostolic Vigils. But taverners are such rascals that they call them flesh, to get more money. Thus I departed, and thought the matter over, and, by the Lord, Master Gratius, I am in a mighty quandary and know not what to do. It seemeth to me that these young fowls in eggs are flesh, because their substance is formed and fashioned into the limbs and body of an animal, and possesseth a vital principle. It is different in the case of cheese mites and such-like, because grubs are accounted fish, as I learnt from a man who is skilled in natural history. Most earnestly do I entreat you to resolve the question I have propounded, for if you hold that the sin is mortal, then I would fain get schrift here before I return to Germany."

Actually the above letter was written by a Protestant to ridicule Catholic hair splitting, but it is indicative of the role of theologic embryology. Except for that which is imbedded still in the doctrines of Catholicism, theologic embryology is no longer a part of the science. That science and theology interacted to a high degree in the eighteenth century, however, cannot be denied. This is evidenced in the very unequal emphasis on masturbation by eighteenth-century moral theologians. The sin of the male in this matter was held to be little short of murder, whereas the female committed no sin. Surely the influence of the school of preformation known as the animalculists is shown by this example. Abortion, birth control, euthanasia, sterilization, masturbation, and other socio-biologic problems were considered by the theologians in the light of what they believed to be embryonic facts. It might have been much better if certain biological questions had been left to the biologist and certain moral considerations in turn left to the theologians.

The question of epigenesis versus preformation and the arguments as to which of the two positions was most correct was not well defined in earlier times. But by the year 1675 the work of William Harvey on the one hand and the work of Marcello Malpighi on the other clearly drew the lines of the controversy. It is interesting that such different conclusions could be drawn by two men—both skilled scientists and both working with much the same material. From a study of this controversy one cannot help but gain an insight into some of the vagaries of the development of scientific ideas.

The development of the doctrine of preformation as it was presented, enlarged, and finally refuted in the period from 1675 to 1775 had its roots in antiquity. But the acceptance of the idea by many eighteenth century

biologists can be traced to the study of certain phenomena, and a misinterpretation of these phenomena by a few important researchers. Further acceptance of the theory is explainable in the light of the religious climate of the times and in the light of the popularity of rationalism.

Probably one man more than any other is responsible for the opening of the modern phase of preformationism. This man was Marcello Malpighi (1628-1694). Embryogeny, Malpighi held, was not comparable to the building of an artificial machine, in which one part is made after another part, and all parts then gradually assembled, but rather it is an unfolding of what was already there, like a Japanese paper flower. He was led to this belief because in studying the development of the chick embryo he could never find an absolutely undeveloped germ spot. How fickle the ways of Fate! Malpighi performed his experiments in August on some very warm nights. As a consequence the embryo had undergone even more than normal development since it had been fertilized in the oviduct. Had Malpighi examined an unlaidd hen's egg it is probable that he never would have formed this theory and the epigenesis controversy would have been settled with Harvey. Yet in fairness to Malpighi it must be said that his view was much more sensible than many which succeeded it, for he did not maintain a perfectly equal swelling up of all parts existing at the start, but rather an unequal unfolding, a distribution of the rate of growth at different times and in different regions of the body. Thus he says, "Now, as Tully says, death truly belongs neither to the living nor to the dead, and I think that something similar holds of the first beginnings of animals, for when we inquire carefully into the production of animals out of their eggs, we always find the animal there, so that our labor is repaid and we see an emerging manifestation of parts successively, but never the first origin of any of them." Were that others had been so temperate in their descriptions.

And so it came that what had been unfounded speculation for Seneca in early times and speculation for Joseph de Aromatari and Everard in late times was set on a firm experimental basis by Malpighi. At about the same time that Malpighi was doing his microscopic studies on the early chick, a Hollander, Jan Swammerdam, was investigating insect metamorphosis. Swammerdam hardened a chrysalis with alcohol, and saw within the cocoon the perfectly formed folded adult butterfly. He concluded that the butterfly had been hidden or masked in the caterpillar and thence also hidden in the egg. Each butterfly in each cocoon must then contain eggs within it which in their turn must contain butterflies which in their turn must contain eggs and so ad infinitum. Swammerdam was a man of strong religious inclinations and soon he extended his preformation theory to man. "In

nature," he said, "there is no generation but only propagation, the growth of parts. Thus the original sin is explained, for all men were contained in the organs of Adam and Eve. When their stock of eggs is finished, the human race will cease to be."

On the basis of the work of Malpighi and Swammerdam the theory of preformation gained momentum at the beginning of the eighteenth century and by 1720 it was thoroughly established. Just to what extent and in what manner the individual was regarded as being preformed or how the myriads of preformed individuals were arranged in either the sperm or the egg was, however, a matter of much speculation. One of the ideas was that of emboitement or encapsulation—the Germans called it *Einschätelung*. On the human level this meant that all the human race was contained in the magnificent ovary of Eve. Indeed, one biologist went so far as to include all human parasites therein too. Of course, most of these ideas were carried to ridiculous extremes in a few decades and the theory of pre-existence had to be refined. Many were the flaws in the theory and many were the controversies that raged among the preformationists themselves. To illustrate further the intellectual climate of this period of history a closer look will be given to one of these struggles, that carried on between the ovists and the animalculists.

With the discovery of the sperm or little animalcules by Leeuwenhoek, and with the assertions by Andry, Dalenpatius, and Gautier that they had seen complete minute men within spermatazoa a more firm foundation was given to the doctrine of preformation. It was a foundation that held its own destruction however, for there now arose a basic rift that separated the preformationists into two camps. On the one side were the ovists who held that all embryos were pre-existing in the ovum, on the other the animalculists who thought that all embryos were preformed in the spermatazoa. Theologically there arose a controversy as to whether all humankind arose from the magnificent ovary of Eve or the glorious testicle of Adam. Among the ovists of the eighteenth century can be named Malpighi, Swammerdam, Bonnet, von Haller, Winslow, Vallisneri, Ruysch, and Spallanzani. Bonnet had rediscovered parthenogenesis in the aphids and based much of his ovist proof on that fact. Most of the others had worked with the chick embryo.

The side of the animalculist preformationists had fewer exponents but included such great names as Leeuwenhoek, Hartsoeker, Leibnitz, and the Cardinal de Polignac. Philosophically as well as egotistically the animalculist theory had more appeal. Aristotle had long before spoken of the father giving form to the substance of the mother. He further likened the

menstrual fluid to marble and the seminal fluid to the sculptor and chisel. Earlier the Egyptians held that the father alone is the author of generation, the mother merely provides nourishment. As late as 1805 Good wrote, "Every naturalist and indeed every man who pretended to the smallest portion of medical science was convinced that his children were no more related, in point of actual generation, to his own wife, than they were to his neighbors."

Other evidence for the animalculist cause came from the imaginations of such men as Hartsoecker, Dalenpatius, and Gautier who saw and drew microscopic little men and even horses and donkeys. Other workers had not been able to see quite the detail seen by these gifted men and the ovists soon led the attack that discredited animalculism. Certain theological objections caused rather absurd theories to be put forth by the champions of animalculism. For example, the objection to the tremendous waste that must occur with the discharge of so many sperm cells was accounted for by James Cooke. Cooke elaborated a world of the unborn to which the spermatozoa could retire between each attempt to find a uterus in which they could develop. Cooke wrote the following in 1762:

"All those other attending animalcula, except that single one that is then conceived, evaporate away, and return back into the atmosphere again, whence it is very likely they immediately proceeded; into the open air, I say, the common receptacle of all such disengaged minute sublunary bodies; and do there circulate about with other semina, where, perhaps, they do not absolutely die, but live a latent life, in an insensible or dormant state, like swallows in winter, lying quite still like a stopped watch when let down, till they are received afresh into some other male body of the proper kind, to run a fresh chance for a lucky conception; for it is very hard to conceive that nature is so idly luxurious of seeds thus only to destroy them, and to make myriads of them subservient to but a single one."

Cooke's admirable hypothesis is an excellent commentary on the evils of extreme rationalism. Another bit of support for the animalculists came from Andry who showed that spermatozoa were not present in young boys or old men. Some followers of Leeuwenhoek could see spermatric animalcules of both sexes, these coupled, and the females gave birth to smaller animalcules. A present day worker can only marvel at the excellence of some of the early microscopes!

As might be suspected the animalculist theory of preformation fell into disrepute through its own excesses. Ovism, on the other hand, seemed to be a better explanation of the facts. It is among the ovists that we find the more rigorous thinkers of the time. Von Haller looked with much skepticism at the work of the animalculists but was nevertheless led away from an early

acceptance of epigenesis by his own work on the chick. Spallanzani came to the conclusion of the pre-existence of the germ within the ovum as a result of his work on the embryology of the frog. Others working with plants found the embryo within the ungerminated seed and saw evidence anew of preformation. The final overthrow of the theory had to wait more conclusive evidence than was then at hand.

If the chemical history of the time is recalled it will be remembered that this was the century of the phlogiston hypothesis. There seem to be many parallels between the rise and fall of that false doctrine and the one of preformation. Both are indicative of the times. Looking back over the meager theoretical progress that was made during this period, in spite of the abundance of new facts uncovered, the comment of one writer seems extremely appropriate, "The controversy between the ovists and animalculists had lasted just a century, and it is not uninteresting to reflect that the general attitude was little changed. When the period opened almost all biologists were preformationists and ovists; at its close they were for the most part ovists and preformationists."

It was earlier pointed out that the theory of preformation was opposed during the eighteenth century by the theory of epigenesis which held that the embryo developed and differentiated from the fertilized germ. Among the supporters of epigenesis were William Harvey, Descartes, Maitre-Jan, and Needham. Later workers included Wolff, Hales, and von Baer. After 1750 Wolff and von Baer brought about a complete victory for the point of view which these men championed. Three arguments against preformationism were as follows: (1) That it is impossible to explain the formation of monsters on a preformation theory; (2) that preformation is incompatible with the facts of regeneration; (3) that the extraordinary resemblance between small embryos of mammals, birds, reptiles, and fishes discredits preformation.

Though these arguments were used effectively the old ideas were very slow to die. The work of Wolff went for the most part unnoticed or uncredited. It was not until von Baer actually discovered the mammalian ovum that the death knell of preformationism was tolled. Modern day scientists may well ask how such a seemingly preposterous idea could have carried the minds of men for so long a time. Perhaps it can best be explained at the manifestation of two conditions. One of these can be considered as preformationism as a manifestation of the wisdom and goodness of God in natural creation; the other, preformation as manifestation of rationalism.

The first of these conditions is one that has only recently been ex-

punged from biologic thought, and even now not completely so. It arose in the medieval mind which was obsessed with the ideas of perfection, good and bad, noble and ignoble, beautiful and ugly, all terms that do not have a biological meaning but that were nevertheless conditioning the thinking of the eighteenth century scholar. The idea of the "perfectly shaped egg", the more noble sex, the noble metals—all of these were value terms much used by the Scholastics.

In the eighteenth century the same frame of mind persisted. Biology was not free from the mental bias of theology. The theological naturalists hailed with enthusiasm the monogamy of the tortoise, and mother-love in goats; they ignored the habits of the hookworm, or the appearances of human monsters. It is not surprising then that this same frame of mind supported wholeheartedly a line of thought that so conveniently coincided with preconceived ideas of the soul and the generation of all things from the original pattern created by an almighty and munificent God.

The second condition, that of rationality, ran parallel to the chief philosophical battle of the period. This was the century of the empiricists in England and the rationalists and romanticists on the Continent. The dogmatic manner in which the preformationism was held during the eighteenth century is epitomized in the statement of Charles Bonnet to the effect that the preformation theory was one of the most striking victories of understanding over the senses. It might better have been described as one of the most striking victories of the imagination over the understanding.

Suggested Reading

Meyer, Arthur William. 1939. *The rise of embryology*. Stanford. Stanford University Press.

Needham, Joseph. 1934. *A history of embryology*. Cambridge. At the University Press.

Singer, Charles. 1950. *A history of biology*. New York. Henry Schuman.

AMONG THE MINNOWS

O whale among the minnows,
Are you serene?
When wave uplifts and furrows,
Are you content?—
Nor ask?—nor question your bulk?
Is life a level,
The maintenance of hulk?
Is your destruction
Of no poignancy?—your end
The glazing of eye?

O whale, not so with me!
In hunger and thirst,
Between earth's lands and sea,
I roam in search
Of stature beyond my form,
Of rapture to burst
My frame.—In final storm
To wing!—to ascend!
O whale, I roam such seas
That never end.

Vera Koehring
Hunter College

Natural Order and Communities¹

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THE CONCEPT of natural order as applied to living things has intrigued generations of philosophers, naturalists and biologists. The stream of historical thought on order or pattern in nature continues as a broad tributary in varied aspects of recent biological work.

The fount of the idea of natural order in western thought is found in Plato's world of ideas which suggests that the created world is patterned after an ideal world. The substance of this doctrine is that creation had to be perfect; nature, therefore, is full and complete, without gaps, and everything, living and nonliving, has its place in the grand design. This doctrine of the fullness of nature has been called by Lovejoy (15) "the principle of plenitude." Lovejoy also notes an influential concept, stemming from Aristotle, which he describes as the "principle of continuity." Although Aristotle is commonly represented as maintaining the existence of clearcut divisions or classes, frequently called "Aristotelian," he also recognized the existence of minute gradations between classes, and of intermediate zones. He provides, in fact, a definition of a continuum; "Things are said to be continuous whenever there is one and the same limit of both wherein they overlap and which they possess in common" (15). Implicit in this contrast is one of the principle divergences in current biological thought, especially in taxonomy and ecology; namely the difference between, "the habit of thinking in discrete, well-defined class concepts and that of thinking in terms of continuity" (15). Aristotle developed the idea of the organization of nature in a scale or hierarchy of forms; "all things are arranged in order in a certain manner but not in the same manner—birds, and beasts and plants. They are not disposed in such a way that there is nothing which relates one to the other" (1).

Stemming from the views, metaphysical and biological, of Plato and Aristotle was the medieval conception of the universe as a great chain of being. This idea derived from the concepts of plenitude and continuity,

¹ Presented at a seminar at the Kellogg Gull Lake Biological Station of Michigan State University in the summer of 1959.

regarding nature as an infinite number of links in a hierarchical sequence to the highest possible being, was accepted as a pattern of nature through the eighteenth century, by philosophers, naturalists and poets.

"Look Nature through, 'tis neat gradation all.
By what minute degrees her scale extends!" (15)

The view of the earth as fully populated by a host of living organisms each fitting into its place in some pattern supernaturally or mechanistically ordered has a long tradition and has continued as an important premise in natural history and biological, especially evolutionary, thought. Gilbert White asserted, "It is, I find, in zoology as it is in botany; all nature is so full that that district produces the greatest variety which is most examined" (22). Thomas Henry Huxley is credited with an analogy of the fullness of life on the earth. He described it as a barrel brimful with apples. The spaces between the apples can be filled with pebbles and the remaining smaller spaces filled with sand. The space in the barrel is not yet filled and water may be poured in to occupy it. This analogy illustrates the evolutionary process of radiation of organisms to fill existing gaps in nature, to invade unoccupied niches, and thus the tendency of natural environments to become more fully occupied. The evolutionary viewpoint is anticipated in the philosophy of the eighteenth century by the transformation of the chain of being from a fixed created order to a doctrine of progressive development, of fulfillment of a cosmic plan.

From the chain of being, viewed as a process of becoming, it is a brief step to Charles Darwin's web of life. In the chain of being the idea of the inter-relatedness of organisms was clear. The metaphysical idea of a linking of the elements of the universe was given a physical dimension in biological evolution and its offshoots. Loewenberg (16) says, "Darwin did not sunder the great chain of being; he provided it with new conceptual links." Paul Sears (20, 21) has pointed out that one of the logical developments of the Darwinian idea of natural selection and its inherent emphasis on the relation of organism and environment is the study of ecology. As one of the recent branches of the intellectual lineage concerned with the organization of nature, ecology is concerned with the pattern and processes involved in groups of plants and animals, in a word with communities.

Perhaps the earliest recognition of organisms as associated groups is that of Humboldt who referred to associations of plants (13). In 1838 Grisebach (12) recognized physiognomically distinct vegetational areas which he called formations. In 1863 Kerner (14) stated "Every plant has its place, its time, its function and its meaning. . . . In every zone the plants are gathered into

definite groups which appear either as developing or as finished communities but never transgress the orderly structure and correct composition of their kind.”; and by 1877 Mobius (18), recognizing that all organisms living together comprise the community, proposed the name biocoenosis. The work of these pioneers and their successors, enriched by evolutionary concepts, has given the concept of the community as a unit of organization and evolution prominence in any consideration of pattern in nature.

One concept of community organization, which has exerted great influence is that propounded by F. E. Clements, a pioneer American plant ecologist. He believed that a community was a group of closely interacting organisms possessing a considerable degree of unity. Borrowing from the philosophy of holism he attributed emergent properties to the community. Emergence infers the “appearance of new, non-preexisting phenomena or conditions as a result of the proper conjunction of individual phenomena” (10). The community was, in his view, an organic entity and as a consequence of the complex relationships between the individual members of the community it represents a kind of organism. Just as an individual plant or animal has properties qualitatively differing from its cellular components, a community may also have such emergent properties and like a biological organism may arise, grow, mature, reproduce itself and die. As developed by Clements and Shelford (6) in the biome concept, it incorporated both plants and animals as indivisible components. Further, the order postulated was that of a hierarchy of classes each representing a subdivision or stage in the development of the optimum community in any region, the climax. Although this climax community was referred to by Clements as “concrete” it was an abstraction of the individual representations or stands of the community in an area. It is important to bear in mind the distinction between the individual community as a physical fact and the community as a concept representing the synthesis of individual stands into an abstract entity. The idea of communities as organisms in the biological sense of the word is one of the tenets from which is derived the concept of communities as units subject to classification in the same fashion as species. Organismic concepts are found in American and European ecological thought and have been frequently asserted. “Every life community forms together with the environment which it fills, a unity, and often a unity so closed in itself, that it must be called an organism of the highest order” (4).

Although the organismic concept of communities is not generally accepted, the concept of communities as comprised of interdependent species of organisms constituting a well-integrated unit of organization is one of

the traditional expressions of an ecological view of order in nature. The integration of communities as evolutionary units is expressed in the following statement of Dice (9). "The evolution that occurs in communities takes place primarily through changes in the characters and behavior of the several member species. The community, however, directs the evolution of each member species through its control of natural selection. The evolution of every species is thus shaped by the character of the community as a whole. Each community tends to evolve the highest degree of adjustment to its habitat that is possible within the limitations of the species available in its region." The community is thus a product of the evolution of the component species and in a complex feedback mechanism modifies the evolution of the member species by influencing the basic process of natural selection. A classification of unit communities into larger entities has the advantage of systematizing the manifold complexities of natural aggregations of living things into ordered forms which can be comprehended and studied.

The question raised by many in attempting to apply such a view of community organization is: how limited or determinate are the aggregations of organisms in nature? A heterogeneous mixture of chemical elements in a given range of environmental conditions will produce only a limited fraction of the possible combinations of elements. The limits are imposed by the properties of the elements and their proportions. Similarly, in any area the available flora and fauna do not occur together in all possible combinations but in limited combinations and proportions of the available species. At the level of community organization a limit is imposed upon diversity by physical, biological, or ecological factors. A consequence of this limitation on the potential combinations of living things is a more or less well-defined series of individual stands which are approximately repeated giving rise to the recognition of familiar classes or types of community as prairie, or maple-beech forest. Not all combinations of species occur in nature, only some of the possibilities are realized. If the interspecific correlations among species are sufficiently restricted, the classification of replicates of species groups should provide a convenient community systematics.

Not all ecologists agree that such a classification is possible. H. A. Gleason advanced, in 1926, the "Individualistic Hypothesis" (11) which asserts, in brief, that each species is distributed according to its individual potentialities and that the environment, varying continuously in time and space, selects from the available organisms those species which compose the community and eliminates the others. If the environment varies continuously

in time and space, communities will also vary continuously. This view introduces a large element of chance into the organization of communities in contrast to the rather deterministic organismic concept. Any number of chance combinations of organisms and environment may be imagined and enough will find a place in nature to make exact replicates of a community type extremely improbable.

It is apparent that organisms are not distributed in nature at random, nor in rigid patterns. The examination of the heterogeneous structure of the living mosaic of the earth and a search for explanations of its complexity is one of the primary challenges facing the ecologist. The two extreme views cited above represent the poles of current thought on the organization of living things in communities. One extreme postulates that the individual species of a community are highly integrated and this integration increases the survival value of the interacting species. It also ascribes to the community a reality as a unit which permits of classification into discrete classes. The alternative view maintains that communities are not units, that there are not discontinuities in natural aggregations and that each species evolves and is distributed according to its own reactions to environmental conditions.

The crux of the empirical examination of these propositions is whether species have geographical ranges and ecological tolerances such that certain species tend to occur together as groups. The total number of species in a region would then form a very much smaller number of groups than would be expected if the possible combinations of species were less restricted. The study of order in nature as manifest in communal relationships between organisms has been stimulated largely by the hypothesis of communities as emergent organisms. Most scientific observation, as Darwin noted, must be either for or against some view and the organismic concept has served this purpose.

Numerous workers have noted how species combinations vary in space. Gleason (11) notes how the flood plain forests along the Mississippi from its northern tributaries to the mouth gradually change in composition as species enter or drop out. These gradual differences cumulate until an almost complete change in composition results. Billings (3) found in the shadscale vegetation of Nevada, that the ranges of each of the major woody species are each different and independent of each other and that the area of overlap is relatively small. Bodenheimer (4), in a study of animal abundance in Palestine, cites the "independent variation and distribution of every species."

Others have recorded the changes of species composition in time. In the

interesting experimental approach of Woodruff (24) a culture medium of bacteria is inoculated with a mixed stock of protozoa and a definite series of protozoan dominants develops, no two of which exhibit the same distribution over the time scale. The concept of successional change is based on the changes of species combinations over time. This may be thought of as a replacement of one community group by another or, alternatively, as a pattern of individual species changes in which each species, as it enters the sequence, increases to an optimum and then decreases until it disappears. Woodruff's experiments exemplify the latter. Changes in species composition over much longer time scales have been noted. Baker (2) cites the elimination of one hundred and ninety-one species of animal from the North American fauna during the migrations of the Pleistocene with little concomitant change in the flora. Mason (17) describes the historical succession of the redwood and its associates on a geological time scale and stresses the individual course of the history of species populations.

Emerging in much current work are new insights into the pattern and order among organisms. Community is less a noun naming aggregations of organisms than it is descriptive of relations between species. The approaches used have varied from the examination of species distributions on environmental gradients to the development of phytosociological scales which may be used to establish the order or relationships among species independently of environmental considerations.

It is a biological commonplace that many characteristics of living organisms are distributed in the form of a normal curve of frequency. Less well recognized is the fact that the distribution of a species population level on an environmental gradient similarly forms a normal, bell shaped curve and that these curves appear as an overlapping series in which no two curves have an identical distribution on the gradient (Whittaker, 23). These curves illustrate the ecological amplitude of the species as related to specific environmental gradients. The same result is obtained from the distribution of species populations relative to various types of axes constructed from the proportionate composition of the species present (Curtis and McIntosh, 8, Bray and Curtis, 5). Observations of this type argue against discontinuity in the organization of communities and therefore against the concept of unit communities subject to classification. It is interesting to note that in both plants and animals, species of the large taxa are variously distributed along a gradient. Curtis (7) cites the distribution of *Aster*, *Liatris* and *Solidago* "in all sections of the continuum. No important genus has all of its species with optima in the same general region of the gradient." Bodenheimer (4) referring to a study of beetles

says "the distribution of every species in the different biotopes shows a fluctuation of its own, independent of the other members of the same 'association'."

If one maintains that communities are not entities it does not follow that the result is chaos. Not all things are equally probable and although attempts to fit natural communities into systems have not been notably successful the distribution of organisms is not a melange. In a recent paper on the "Science and Philosophy of the Community Concept" Muller (19) considers a newly formed pond as yet unoccupied by living organisms. Many living things may arrive at the pond and establish a pond community. The early arrivals modify the pristine conditions of the pond and each new arrival finds slightly different conditions created by the other organisms and in turn modifies the environment in some way. There is no guarantee that any two ponds will develop in similar manner since there is an element of chance in the development of each individual pond. The similarity of ponds as distinct from hilltops is apparent but the differences between ponds are frequently overlooked. This diversity of similar communities Muller attributes to what he calls "the principle of limited indeterminacy." This is an element of chance or randomness in biological phenomena akin to the Heisenberg "uncertainty principle." In part, variations between ponds are partially indeterminate and are not therefore attributable to absolute causality. In part, however, the variations between pond communities or other similar communities of living things are due to variations in the habitat complex which result in gradually changing species complexes.

A community is thus visualized as a continuous, orderly pattern of species individually distributed in time and space and most effectively considered in terms of gradients, orders and probabilities. Species having ecological amplitudes over similar sectors of the gradient have greater probabilities of being represented in frequent combinations in nature. The chain of being has a much modified descendant in the continuous pattern of overlapping curves. Each curve has its own optimal point, these being distributed uniformly along a gradient and, as additional species are studied, their optima are interspersed among the others, seemingly leaving no niche unfilled.

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Book Notices

Introduction to Human Anatomy. Third Edition by CARL C. FRANCIS. 1959. C. V. Mosby Co., St. Louis. 548 pp., 324 figs. \$5.75.

An elementary text for undergraduates.

Readings in General Psychology. Edited by PAUL HALMOS and ALAN ILIFFE. 1959. Philosophical Library. New York. 251 pp. \$6.

This is a series of 15 papers by various British psychologists designed as collateral

reading for students. Topics such as "The Scientific Status of Psychology," "The Psychology of Thinking," "The Interpretation of Intelligence Test Results," and "The Status of Instinct" are among those covered. Whatever one's view of Freud, one cannot but admire Ernest Jones definition (p. 182) of normality as "fearlessness. The most normal person...[has] the willing or even joyful acceptance of life, with all its visitations and chances, that distinguishes the free personality of one who is master of himself."

Egypt's New High Dam—Asset or Liability

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THE PROPOSED new "High Dam" on the Nile at Asswan in Egypt has had much publicity. The proposal has been widely discussed by economists, political scientists, sociologists, those interested in agriculture, and politicians, but one can find no reference anywhere to the unfortunate difficulties in the field of public health that will become accentuated in that country when the dam is built. An interesting set of biological conditions surround this problem. While the information given here is perhaps not new to the health authorities in Egypt or to other agencies such as the World Health Organization, under whose auspices much of the medical and biological work was done, the nature of the problems in Egypt itself is not generally appreciated among biologists. The conditions are such that it seems difficult to understand why Egypt would embark on a program estimated to cost a billion, three hundred million dollars when there is evidence that the high incidence of human blood fluke (schistosomiasis or bilharziasis) in the area may well cancel out the benefits the construction of this dam may yield. That Egypt cannot afford to embark on so expensive an undertaking in its present health status was indicated by the study of John Weir (1952) who stated:

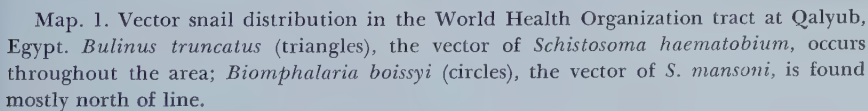
"The overwhelming magnitude of the problem of rural health and social development in the rural areas of Egypt has been clearly shown in this study. In general the village population is one of an extremely low economic status, with a low but improving literacy rate, and with a pressing need for social and community development. The burden of disease carried by the population is heavy. Nutritional deficiencies, epidemic and chronic eye diseases, enteric fevers and dysenteries, tuberculosis, syphilis, and bilharzia are all found at extremely high levels in the village population. All would seem to have equal priority in attempts to control or abate disease in rural Egypt."

It is generally conceded that schistosomiasis or human blood fluke has now replaced malaria as a chief hindrance to progress in many underdeveloped regions of the world. Significant advances in knowledge of mosquito biology and the skillful use of insecticides have reduced malaria

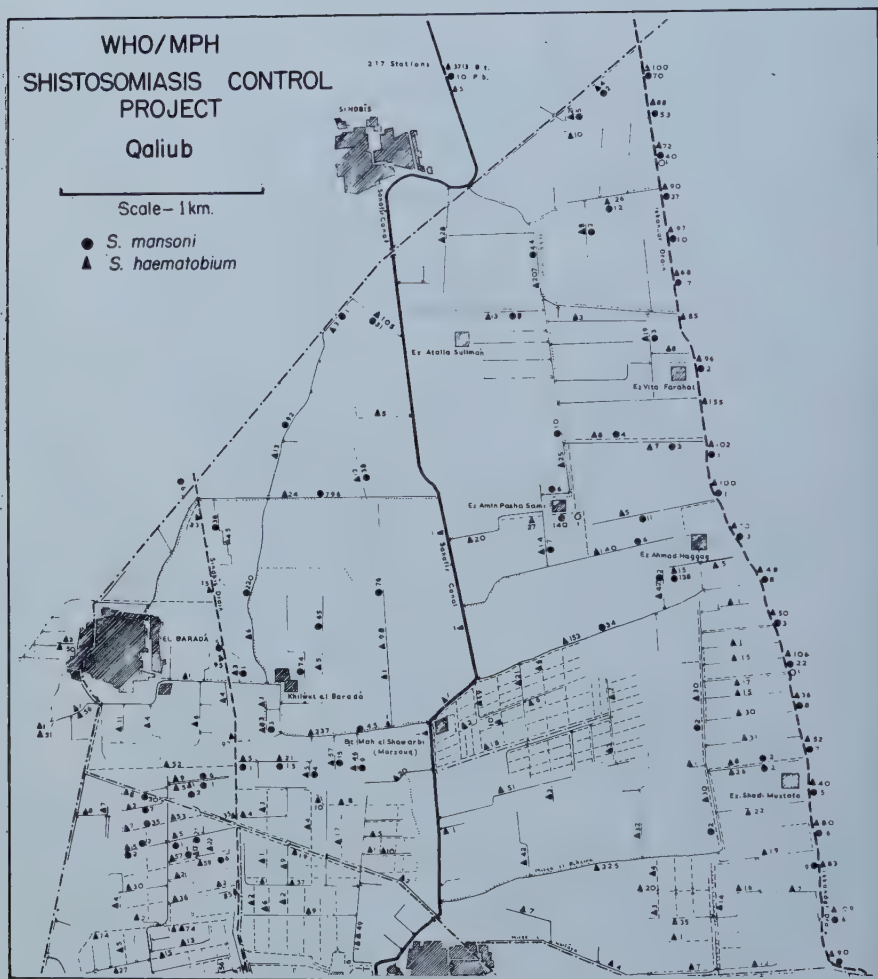
considerably. Conditions are quite different with schistosomiasis and this disease will probably retard greatly the development of many regions in Africa. Areas such as the Gezira in the Sudan, where some million acres have been irrigated since the first world war, are trying desperately to hold down the rising incidence of blood fluke. Egypt has had the disease since Pharonic time and the incidence of both the intestinal (*Schistosoma mansoni*) and bladder or vesicular (*Schistosoma haematobium*) species has reached alarming proportions.

To appreciate the problem some information about the life history of the human blood flukes common in Egypt is given. One should also appreciate the role of the two species of snail intermediate hosts. Those who know the cycle will recall that the adult worms or "flukes" live paired in the venous blood vessels surrounding the intestines (*S. mansoni*) or in the blood vessels surrounding the bladder (*S. haematobium*). The eggs produced by the adult worms escape from the human body with the faeces or urine. When they reach natural waters (canals, drains, rivers, etc.), small ciliated larvae (miracidia) hatch and penetrate snails. The miracidia of *S. mansoni* penetrate *Biomphalaria* snails; those of *S. haematobium* enter species of *Bulinus*. Under warm conditions (about 25°C) it takes about a month of development in the snails to produce the infective larvae or cercariae. They are free swimming and so small as to be hardly visible to the naked eye. They readily bore into the exposed skin of people engaged in swimming, drinking, irrigating fields, washing clothes, performing ablutions, watering the gamoosa, etc.,—the many ways in which native people come in contact with natural waters in an agricultural economy. In Egypt the amount of exposure of the farmers, or fellaheen, to infected waters is so high that in some villages practically all of the people have the disease.

During a three-year period between 1952 and 1954 a special World Health Organization project (Egypt 10) was undertaken in a 5,000 acre tract of the Nile Delta about 12 kilometers north of Cairo. This tract had six villages and 32,000 inhabitants. Four programs, representing phases of blood fluke control carried out in various parts of Egypt by different groups, were undertaken in this tract (see Map 1) simultaneously. The teams were organized for: (1) medical work involving the measurement of incidence and treatment with an antimonial drug (stibophen); (2) sanitation by providing wells and latrines; (3) health education in the villages to inform the inhabitants about the dangers of contaminating water and being exposed to infection; and (4) snail control to determine the distribution of the intermediate hosts and the foci of infection. Since snail control appears to be one of the best ways to prevent infection and because it is so closely related to the problems stressed here, only this phase of the work will be



The base map (Maps 1 and 2), prepared with the assistance of personnel in the Ministry of Health in Cairo, shows the tremendous amount of water



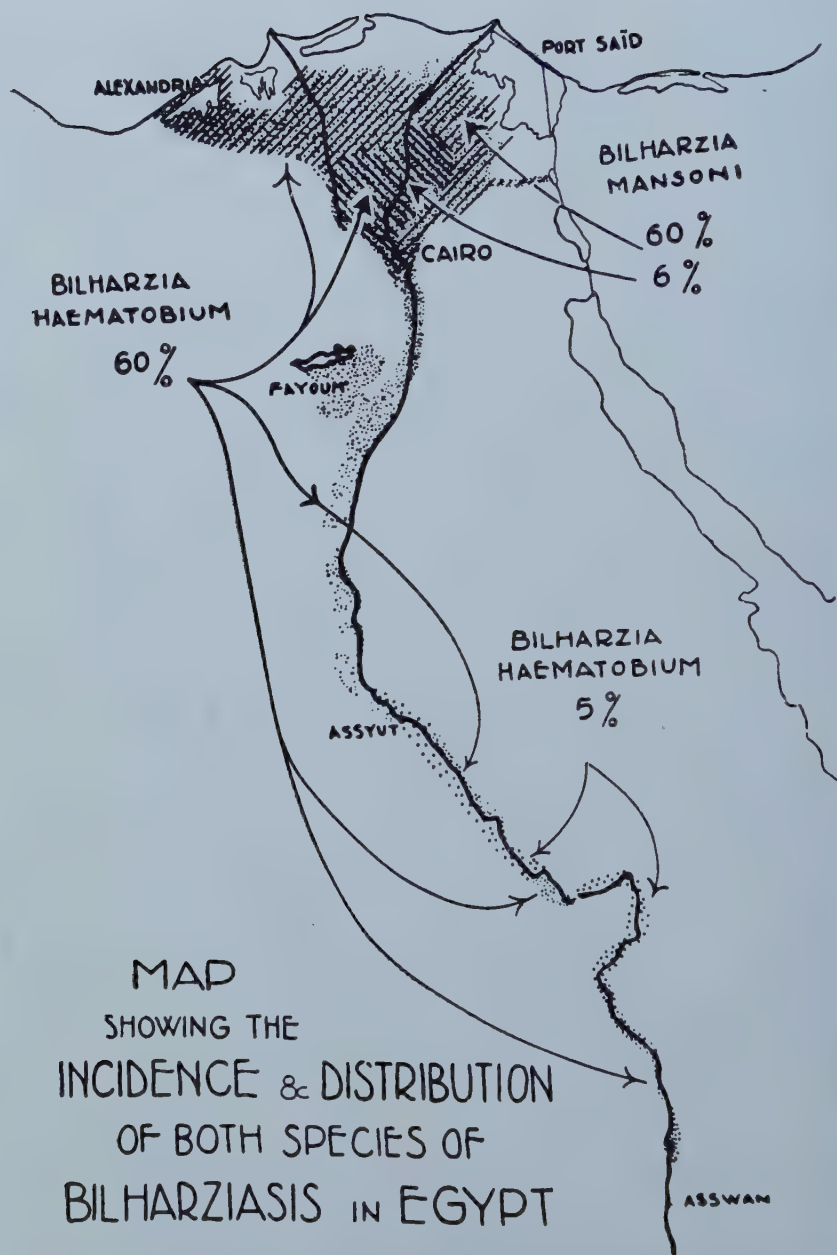
Map. 2. Enlargement of northern part of WHO tract near Qalyub indicating that this area is at the southern limit in the distribution of *Biomphalaria boissyi*, the intermediate host of *Schistosoma mansoni*.

(some 450 kilometers of canals and drains) concentrated by the perennial system of irrigation in this 5,000 acre pilot area. A systematic survey of all of the canals and drains was undertaken between February and mid-July of 1953. The distribution of the two vector snails was plotted. The vector of vesicular schistosomiasis or *Bulinus truncatus* (represented by triangles) was widespread throughout the whole area and *S. haematobium* was a

dominant parasite among the inhabitants (some 14,000 of 28,000 people examined were positive). The vectors of intestinal schistosomiasis, *Biomphalaria boissyi* (more recently called *B. alexandrina* and represented on the map by circles), were restricted to the northern part of the tract where only 200 cases of *S. mansoni* were found in the pilot area. A more detailed account of the vector snail control work in Qalyub was published by Henry van der Schalie (1958).

If one examines the distribution of the two intermediate hosts, as shown on Map 1, and compares their pattern of distribution with a map published in 1937 by J. Allen Scott (Map 3), it is obvious that the southern limit of *Biomphalaria* in Egypt is just at the level of the northern part of the Qalyub tract. As pointed out by Scott, the high incidence of human blood fluke in the Delta is correlated with perennial irrigation there. In the Nile above Cairo and for a distance of about 500 miles by river to Asswan, farming is now done mostly by the basin system of irrigation. This method involves holding the waters after the flood period in the summer long enough to plant a single crop. In that basin system Egypt has but a few foci of high *S. haematobium* infection while the many miles of river between Cairo and Asswan harbor only about five per cent of vesicular blood fluke.

With the above basic information in mind, what are the implications of constructing the high dam to the incidence of schistosomiasis? It is clear from the pattern of the disease and its relation to the two vector snails, that converting the Nile basin above Cairo to perennial irrigation will at least increase the incidence of vesicular blood fluke to 60 or more percent. While at present the ecological conditions relating to *Biomphalaria* are not well understood there seems to be a good chance that this *S. mansoni*-carrying snail may become established throughout the upper Nile after the irrigation system has been changed to a perennial system. One should bear in mind that there are approximately 23 million Egyptians and they must live on about 6 million arable acres. To increase food production the high dam is given high priority, and with the population increase of about half a million Egyptians per year more acreage and a four crop or perennial system becomes imperative. But as M. Abdel Azim (1948) stated: "Upper Egypt, from Asswan to Assyut, with the exception of small districts, is still under basin irrigation. The permanent canals furnish ideal environment for the breeding of the snail vectors of bilharziasis, while their proximity to the villages exposes them to pollution and makes them a source of infection. Thus perennial irrigation is responsible for the high incidence of bilharziasis in areas where it has been established. Future change from basin



Map 3. Illustration from Scott (1937) showing that the high incidence of schistosomiasis in Lower Egypt is correlated with perennial irrigation.

to perennial irrigation will increase the spread of bilharziasis, unless control measures go hand in hand with the development of the new irrigation schemes."

To date, snail control measures have proven both difficult and very expensive. The chemical of choice in Egypt has been copper sulphate. In the Qalyub project a single treatment took forty tons of the chemical at a cost of over thirteen thousand dollars. The next year there were about half as many snails but just as many foci of infection, and by the following year the vector snail population was back to such a high level that one could not detect the tract had ever been treated! More recently better molluscicides have been used and control seems to be more promising with a halogenated phenol (sodium pentachlorophenate). The control measures are still in an experimental stage, and it is possible that an effective chemical method may prove too expensive for so large an area.

Many other aspects of the relation of the parasites to the snail intermediate hosts are as yet only partially known. For example, the results of the work done in Qalyub revealed that the vector snails did not shed cercariae until the middle of May. This periodic condition suggests that the infected snails do not carry their infection through the winter in that area. It has been shown that chilling or cold-stressing the snails harboring human schistosome parasites kills the parasite but not necessarily the snail host. The combination of cold winter conditions and aestivation during the winter closure periods when the canals are allowed to dry to re-establish their gradient undoubtedly eliminates most of the infected snails in nature. But the great amount of pollution taking place in all waters in Egypt immediately produces many sites of snail infections which result in a very high incidence of infection among a population with many forms of contact with natural waters. It is unfortunate that the only source of water for most of the people in villages is restricted to that found in canals and drains.

It would seem that some mention should be made of the relation of schistosomiasis (bilharziasis) to the construction of the high dam at Asswan. It is generally conceded that a disease as debilitating as blood fluke may serve as a very effective means for preventing a population explosion among a people that practices polygamy and where over-population is already a crucial problem. Yet it does not promote confidence in a scheme that is so costly when it seems likely that a disastrous lowering of health standards will ensue. Willard Wright (1951) in a presidential address to the American Society of Parasitologists, stated:

"In Egypt, it is estimated that schistosomiasis is costing the country as a whole

20 million pounds per year. The productivity of the population is decreased by 33 per cent. All of the heavy labor in Egypt is supplied from Upper Egypt, where the disease has a very low incidence. Over a period of years, 22 per cent of Army recruits from Lower Egypt have been rejected for physical defects, whereas only 3 per cent of those from Upper Egypt have failed to pass the physical examinations. This wide difference is believed to be due almost entirely to the high schistosome infection rate in Lower Egypt."

In the same address Wright stated further:

"In spite of the over-all questionable economy of extension of agriculture into the dry lands, many such projects are planned in various parts of the world. It is the invariable result that irrigation projects in endemic areas of malaria and schistosomiasis lead to a rapid extension of these diseases unless adequate consideration is given to their significance in the planning stages. The introduction of perennial irrigation into Egypt has increased the general incidence of schistosomiasis from 5 to 80 per cent. Dr. D. M. Blair of Southern Rhodesia has advised me that the Umshandige Irrigation Scheme installed in that country at a cost of 3,000,000 pounds in 1939 has practically been abandoned and that the extension of schistosomiasis into the area has contributed materially to the failure of the project."

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Principles of Self Damage. EDMUND BERGLER. 1959. Philosophical Library. New York. 469 pp., \$6.

The New Psychiatry. NATHAN MASOR. 1959. Philosophical Library. New York. 155 pp. \$3.75.

These two books, by the same publisher, offer as mutually exclusive accounts of mental illness as would accounts of the origin of man by an evolutionist and by a fundamentalist. The first, by a Freud-

ian, finds the origin of such illness in a "psychic masochism" induced by experiences in the first 1½ years of life and requiring for its treatment months or years of psychoanalysis in depth. The other is by a physician, who suggests that mental illness is the result of physical imbalance and that the treatment is biochemical. Depth or even superficial analysis is held by Dr. Masor to be as likely to be damaging as otherwise. They are both fascinating books.

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Nature and Man's Fate. GARRETT HARDIN. 1959. Rinehart & Co., New York. 374 pp., illus.

This is a penetrating and refreshing account of evolution, heredity, and their implications for man. While not designed for specialists in speciation and genetics, it is a book that most biologists as well as interested laymen can read with profit.

In his opening chapters on evolution's origin, Hardin suggests that Darwin delayed the writing of his famous book in part because of the savage reception accorded *The Vestiges of Creation* in 1844 and speculates that his long preoccupation with barnacles may have been as much a retreat from the controversial subject of the transmutation of species as a taxonomic basis for those same studies. As things worked out, Adam Sedgwick attacked Darwin in 1860 in the same terms that he had attacked *The Vestiges* in 1845, accusing their authors of departing from the strict terms of Baconian induction. This was, apparently, to continue to "gather facts endlessly without preconception or conscious guide, until finally, by some magical process, the facts group themselves into generalizations which you have only to convert into words" (p. 110). The book is further reinforcement of the supreme importance of Darwin's work, suggesting (p. 248) "that even the most modern theory of evolution is only an extended footnote to the *Origin*."

The personal implications of genetics for marriage and child-bearing is explored in Chapter 7, and Chapter 11 tells of the Russian tragedy with the names of at least seven Russian geneticists who were killed by the Russian government for their adhesion to Mendelism. As interesting as any section to the reviewer were those portions of the concluding chapter in which the undesirable biological results of thorough going "one-worldism" are set forth. The author suggested that new gene com-

binations are discouraged in wide ranging interbreeding populations. They are encouraged in small restricted groups. Genetic diversity with its increased likelihood of producing new capacities and capabilities will, therefore, be favored by the existence of numerous reproductively isolated groups. Men must, however, discover how to favor such groups without permitting them to engage in aggression on each other.

Hardin's book contains an eight-page middle section of discriminatingly selected portraits: three generations of Darwins, Wallace, Hooker, Lyell, Huxley, Galton, Mendel and such eminent twentieth century figures as Muller, Wright, Haldane, and Fisher. There is a 214-title bibliography, but, unfortunately, the text's references to it are not very precise, so that one is not told, for instance, the precise source for the statement (p. 35) that Darwin died worth 282,000 pounds.

The author is in error when he states (p. 44) that Wallace read Malthus' *Essay on Population* in the East Indies. Actually, Wallace read this book in England in the mid-forties before he even left England (Wallace's *Autobiography* pp. 232, 240, 361).

Mankind in the Making, the Story of Human Evolution. WILLIAM HOWELLS. 1959. Doubleday & Co., Inc., Garden City. 382 pp., illus. \$4.95.

This is an account by an expert in non-technical language of the evolution of man's body from the jawless fishes of the Paleozoic to the races of *Homo sapiens* that inhabit today's world. Moving to the later stages of the story, the author envisages small australopithecine hominids as in existence in the Old World from the middle Tertiary on. They had a common origin with the great apes, but Howells does not believe that man's ancestors ever had the brachiating habit of those pri-

mates. By the late lower and middle Pleistocene larger brained euhominids had come on the scene: *Pithecanthropus* extending from the Far East to North Africa and Heidelberg man in Europe. The early upper Pleistocene (Third Glacial and Interglacial) saw *Homo neanderthaleusis* in Europe and vicinity, Rhodesian man in southern Africa, Solo man in Java, and the forerunners of *Homo sapiens*—we aren't sure exactly where, but some Third Glacial fragments from the Fontéchevade Cave in central France are suggestive. By about 35,000 B.C. only sapient man remained. Howells conjectures that primitive Mongolians appeared in eastern Asia, later migrating to America, perhaps as early as 15,000 or 20,000 B.C. Caucasian man perhaps arose north of the Himalayas in Asia, the Negro perhaps in the western Sudan, and the Bushmen—Hottentots in South Africa. The book gives absorbing circumstantial accounts of the finding of many of the remains, including "Piltdown Man: His Rise and Fall," but culture is completely outside the author's scope. Throughout Howells emphasizes the incomplete tentative nature of his conclusions, any of which are subject to change as new data and new interpretations become available, so that the book is an interesting example of the scientific method in action. An interesting, competent, and worthwhile book.

Howells shares the view of the editors of *The Scientific American* that an essential ingredient of "popular" science writing is a virtual absence of bibliographical reference. Thus the reader is led into a cul-de-sac. Perhaps the average reader doesn't care, but doesn't the exceptional reader deserve some suggestion as to where to go next?

In and Out of the Ivory Tower: The Autobiography of Richard B. Goldschmidt. 1960. University of Washington Press, Seattle. 352 pp. \$5.75.

This is an important and dramatic account of one of the twentieth century's eminent zoologists. Goldschmidt's life (1878-1958) fell in four acts with three oriental interludes. First the boyhood in

Frankfurt and early-professional success with Richard Hertwig at Munich in Imperial Germany. Then the disaster of World War I, during which Goldschmidt by accident was resident in, later interned in the United States, and its tragic aftermath in Germany. Third came the rebirth of science in the Weimar republic with Goldschmidt coming into his own as the Director of Genetics in the Kaiser Wilhelm Institute in Berlin. Finally there was the Nazi tragedy—Goldschmidt was Jewish—and Goldschmidt's happy residence after 1936 at the University of California in Berkeley. These are the important moments in Goldschmidt's life story, but there came in 1914, in 1924, and in 1929 relaxing interludes in the Far East in search of eastern strains of the gypsy moth, which the author tells about in the same delightful style in which the entire book is written.

Goldschmidt was a vigorous independent thinker. His two middle decades were given largely to the investigation of intersexuality in the gypsy moth, his later years to such unpopular subjects as phenocopies, the non-corpuscular nature of the gene, and macro-evolution. But this is no detailed apology for his scientific work—only a brief concluding chapter treats of this—but the story of the human and cultural life of an eminent zoologist who gave a collection of Chinese tomb figurines to the de Young Museum in San Francisco and for whom a concert meant more than professional success.

This book concludes with a list of 283 titles of Goldschmidt's public writings and a rather inadequate index.

A History of Biology to About the Year 1900. A General Introduction to the Study of Living Things. CHARLES SINGER. 1959. Abelard-Schuman, New York. 3rd edition revised. 580 pp., 193 figs. \$6.00.

From Magic to Science. CHARLES SINGER. 1958. Dover Publications, Inc., New York. xxxii + 253 pp., 14 plates, 108 figs. \$2.00.

These are reprintings of two important works on the history of science. The first is a reset but only slightly rewritten book

first published in 1931 as *The Story of Living Things* with a second slightly revised edition in 1959 as *A History of Biology*. It is intended primarily for persons without previous knowledge of biology, shown by the fact that the biological principles (plankton study, heredity, etc.) are explained before their history is reviewed, but contains some material not available in other histories of biology (i.e., *The First Scientific Societies*, *The Advent of Scientific Journals*, *Early Museums*).

The second is a reprint of a book first issued in 1928, containing seven essays on late Roman and early Medieval science. The essay of most biological import is the fifth on *Early Herbals*, which reproduces some of man's first efforts to make pictures of plants.

De Magnete. WILLIAM GILBERT. Translated by P. FLEURY MOTTELEY. 1958. Dover Publications, Inc., New York. liv + 368 pp., illus. \$2.00.

William Gilbert (1540 or 1544–1603) was one of the first, if not the first, important man of science in England. He was the first to advocate Copernican views in England and suggest that the stars were located at varying distances from the earth. His own great contribution, in which he made strict use of the newly emerging experimental science a generation before Galileo, Bacon, and Harvey, was *On the Magnet and Magnetic Bodies and on the Great Magnet the Earth*, published in Latin in London in 1600, but not translated into English until 1892. The present book is a facsimile reproduction of this 1892 translation. Thus Dover has once again made available in inexpensive form an important classic of physical science.

Biophysical Science—A Study Program. Edited by J. L. ONCLEY, F. O. SCHMITT, R. C. WILLIAMS, M.D. ROSENBERG, R. H. BOET. 1959. John Wiley & Sons, Inc., New York. 610 pp., illus. \$6.50.

This collection of 61 chapters by nearly as many authors emphasizes the blending of the concepts and methods of physical

science with those of the life sciences in the study of biological problems. The viewpoint is essentially that of molecular biology. The chapters are reviews combined with some personal research findings of their authors at numerous points of the advancing biophysical front, and represent papers given at Boulder, Colorado, July 20–August 16, 1958 in a study program conducted by the Biophysics and Biophysical Chemistry Study Section of the National Institutes of Health. They were originally published in the January and April numbers of the *Reviews of Modern Physics*. Many bibliographies. Full index.

A Guide-Book to Biochemistry. KENNETH HARRISON. 1959. Cambridge University Press, New York. 150 pp., cloth \$3.50; paper \$1.95.

On the basis of some knowledge of logarithms and organic chemistry, this book attempts a brief exposition of some of the more important aspects of biochemistry. High energy phosphate bonds, enzyme action (one molecule of enzyme may transform over a million molecules of substrate in one minute, p. 35), biological oxidation, photosynthesis, and carbohydrate, fat, and protein metabolism are surveyed. There is no bibliography, but the makers and dates of many of the important discoveries are noted in the text. The treatment is probably as simple as the recondite subject permits, but may be more useful as a review than as an introduction. A chapter on some of the methods employed in working out these submicroscopic structures and events might have been enlightening.

Lipide Chemistry. DONALD J. HANAHAN with chapters by FRANK R. N. GURD and IRVING ZABIN. 1960. John Wiley & Sons, Inc., New York. 329 pp.

This is a textbook for use in a graduate course in lipide biochemistry. It assumes previous preparation in organic chemistry and general biochemistry. Full bibliography and index.

Medicinal Chemistry. Volume IV. Barbituric Acid Hypnotics. WILBUR J. DORAN. 1959. John Wiley & Sons, New York. 334 pp.

This is a specialized review of this group of chemicals. After considering the chemistry (10 pp.) and pharmacology (25 pp.) of the compounds, 198 pages are devoted to tables, 41 pages to bibliography, 59 pages to a formula index of the compounds considered, and 6 pages to a subject index.

Synthesis and Organization in the Bacterial Cell. ERNEST F. GALE. 1959. John Wiley & Sons, Inc. New York. 110 pp., illus.

Under the headings "Structure and Organization," "Amino Acid Incorporation," and "Nucleic Acid and Protein Synthesis," the author, a member of the Medical Research Council Unit for Chemical Microbiology at Cambridge, England, considers certain recent aspects in the biosynthesis of bacteria. The book is based on the CIBA Lectures in Microbial Biochemistry given at Rutgers, the State University of New Jersey, in March 1959.

Recent Progress in Microbiology. Symposia Held at the VII International Congress for Microbiology Stockholm 1958. Edited by G. TUNEVAL. 1959. Charles C. Thomas, Springfield, Illinois. 453 pp., illus. \$14.00.

This book combines in one volume six symposia on recent aspects of microbiology. Recombination mechanisms in bacteria, the role of protein in nucleic acid synthesis and vice versa, latent and masked virus infections, germ-free animals, and continuous culture methods are some of the topics considered. A notable feature of the volume is the presentation of over 70 pages of the more or less informal discussions that accompanied the symposia giving glimpses, as it were, of the minds of eminent microbiologists in action. The book was printed in Uppsala.

Immunity and Virus Infection. Symposium Held at Vanderbilt University School of Medicine May 1-2, 1958. Edited by

VICTOR A. NAJJAR. 1959. John Wiley & Sons, Inc., New York. 262 pp., illus. \$10.50.

This collection of 20 essays by different authors reviews the mechanism of immunity and virus infection from the standpoint of basic biological principles. Theories of antibody formation are reviewed and the nature of antigen-antibody action is considered. The last three chapters concern poliomyelitis.

The reviewer disagrees with F. M. Burnett's (p. 170) characterization of genetics as the most utilitarian of the biological sciences. This may well be the role of genetics eventually, if and when man takes over his own evolution. At present, however, the reviewer suggests that the most useful branch of biology is that concerned with the control of infectious disease. The average span of human life has been about doubled in consequence of its achievements.

Man and Learning in Modern Society. Papers and Addresses Delivered at the Inauguration of Charles E. Odegaard as President of the University of Washington November 6 and 7, 1958. 1959. University of Washington Press, Seattle. 195 pp., illus. \$5.00.

The specialized biological import of this interesting book is the essay (pp. 70-107) entitled *Round Trip from Space* by Melvin Calvin of the University of California, which presents a high-level account of the way a modern bio-organic chemist sees the problem of the origin of life. The various possible steps are reviewed, involving the concept of "autocatalysts" at a critical stage—the appearance of molecules having the capacity to promote the synthesis of other molecules like themselves. Biologists and others approaching the book to find out about the origin of life will be sure to enjoy the nine or ten other essays treating most perceptively of many matters of current academic and cultural concern.

Radiation Biology. Proceedings of the Second Australian Conference on Radiation Biology Held at the Univer-

sity, Melbourne, 15-18 December, 1958 by the Australian Radiation Society. Edited by J. H. MARTIN. 1959. Academic Press, New York. 304 pp., illus. \$11.00.

This is a collection of 28 papers mostly by Australian workers on this timely subject. Sir F. Mac Farlane Burnet, in the Foreword, reminds us that while a nuclear war would be an "unimaginable calamity" the prevention of which is "the over-riding political and social necessity of our time... the danger associated with limited exposure to ionizing radiation, whether from... natural sources, fall-out from test explosions, the medical uses of X rays, or from work in laboratories and industrial establishments concerned with atomic power, is unimportant in comparison with the ordinary hazards of life." The several papers in the collection are accompanied by bibliography and discussion.

Soil Grass and Cancer. ANDRÉ VOISIN. 1959. Academic Press, New York. 302 pp., illus. \$15.00.

The author's thesis is that the health of animals and men is tied in with trace elements in the soil such as copper, iron, molybdenum, zinc, manganese, etc., and the proper control of such elements is considered a must for adequate agriculture and animal husbandry. Evidence is presented that suggests to the author that traces of copper are an important factor in the occurrence of some types of cancer. A provocative book.

International Review of Cytology. Volume VIII. Edited by G. H. BOURNE and J. F. DANIELLI. 1959. Academic Press, New York. 541 pp., illus. \$13.00.

This book consists of 13 reviews of current aspects of cytology. The structure of cytoplasm, the submicroscopic morphology of the synapse, the cell surface of *Paramecium*, the physiology of chromatophores, and the osmotic properties of living cells are examples of the subjects considered. An essential volume for the cytologist.

Biology. GORDON ALEXANDER. 1959. Barnes and Noble, New York. 7th Edition, reprinted with minor revisions. 253 pp., 7 figs.

A summary of general principles with suggestions as to how to study and a sample examination and answers, keyed to standard textbooks.

An Introduction to Social Biology. ALAN DALE. 1959. Charles C. Thomas, Springfield, Illinois. 434 pp., 199 figs. \$6.50.

This is a high level introduction to biology, with special reference to human affairs. It touches very lightly on classification and hardly at all on biochemistry, but otherwise is an excellent review. The role of insects in disease are dealt with at length but not their influence on food production. The view point in health and population considerations is British, the author foreseeing a static population.

Life Science. THOMAS S. HALL and FLORENCE MOOG. 1957. John Wiley & Sons, Inc., New York. Third Printing Revised. 502 pp., illus.

An up-to-date attractive college textbook of general biology.

Introduction to Plant Physiology. BERNARD S. MEYER, DONALD B. ANDERSON, and RICHARD H. BÖHNING. 1960. D. Van Nostrand Co., Inc., Princeton, N.J. 541 pp., illus.

A broadly conceived text for a one-semester or one quarter course in plant physiology.

British Parasitic Fungi. A Host-parasite Index and a Guide to British Literature on the Fungus Diseases of Cultivated Plants. W. C. MOORE. 1959. Cambridge University Press, New York. xvi + 430 pp. \$8.50.

Pages 3-47 are an alphabetical list of hosts with the fungi infesting each listed alphabetically under each host. Pages 51-

430 are an alphabetical list of fungi, each species accompanied by a bibliography and a review of its incidence with some additional bibliography. No fungi or pathological conditions are described. An essential reference work for plant pathologists and mycologists.

Manual of Vegetation Analysis. STANLEY

A. CAIN and G. M. de OLIVEIRA CASTRO. 1959. Harper & Brothers, New York. 325 pp., 45 figs., 74 tables. \$7.50.

This is a description of methods useful in plant ecology. The junior author is a Brazilian, so that considerable emphasis is placed on methods applicable to the study of a tropical flora as well as to the plant communities of temperate regions. A glossary, ample bibliography, and index conclude the book.

Taxonomy of Flowering Plants. C. L.

PORTER and EVAN L. GILLESPIE. 1960. W. H. Freeman and Co., San Francisco. 452 pp., 600 figs. \$6.75.

This book is an amply documented introduction to the systematic study of the higher plants. The first third of the text is introductory, treating of the aims of taxonomy, its history and literature, field and herbarium methods, nomenclature and the nature of the taxonomic categories, the construction and use of keys, an illustrated guide to the terms used in plant descriptions, and the phylogeny of the angiosperms. This is followed by a 50-page section on the monocotyledons and a 200-page section on the dicotyledons in the course of which selected families are keyed, described, and figured. It is the sort of book that the serious beginning student of plant taxonomy should welcome as an entree to the field.

Illustrated Flora of the Pacific States:

Washington, Oregon, and California. Vol. IV. Bignoniaceae to Compositae, Bignonias to Sunflowers. ROXANA STINCHFIELD FERRIS. 1960. Stanford University Press, Stanford, California. 732 pp., 2124 figs. \$17.50.

The first four volumes of this massive work on vascular plants appeared under the authorship of Le Roy Abrams who died in 1956. This concluding volume is by Mrs. Roxana S. Ferris, Assistant Curator of the Dudley Herbarium at Stanford. It describes and figures 1124 species with notes on numerous subspecies and varieties. There are indices to the scientific and common names in all four volumes and a concluding key to the families treated in the entire work. A sumptuous work brought to a fitting conclusion.

The Morphology and Anatomy of American Species of the Genus *Psaronius*.

JEANNE MORGAN. 1959. Illinois Biological Monographs No. 27, University of Illinois Press, Urbana. 108 pp., 82 figs. cloth \$4.00; paper \$3.00.

This is a fresh assault on the taxonomy of this Permo-carboniferous genus of tree ferns. In it the effort is made to integrate as ontogenetic stages of a single species trunk sections, many of which are of the type that have been regarded as distinct species by previous authors. Six American species of which three are new are described.

Marine Boring and Fouling Organisms.

Edited by DIXY LEE RAY. 1959. University of Washington Press, Seattle. 542 pp., illus. \$8.50.

This collection of some 35 papers was given at a symposium at the Friday Harbor Laboratories of the University of Washington in September 1957. They are arranged under the headings Limoria (115 pp.), Terediniens (64 pp.), Barnacles (62 pp.), Cellulases (178 pp.), and Economic Implications and Evaluations (112 pp.). The reports bridge the gap from taxonomy to biochemistry and from the most basic to applied studies. If any group of papers is out of place it is that on barnacles, which are not referred to again in any of the other four sections. A basic book which workers in any of the included fields will require.

Men and Moments in the History of Science. Edited by HERBERT M. EVANS. 1959. University of Washington Press, Seattle. 226 pp., illus. \$4.50.

This is a collection of nine essays by various members of the History of Science Dinner Club, founded in 1932 on the Berkeley campus of the University of California. The longest is a 55-page study of the history of the second law of thermodynamics. Especially interesting to the reviewer was Otto Struve's account of the first determination of a stellar parallax and E. W. Strong's account of Newton's meaning in his "Hypotheses non Fingo." It appears that the only explanations with which Newton would traffic were such as presented the possibility of verification by further observation and experiment. Unverifiable hypotheses, even though possible, are to be avoided.

The essay of biological importance is E. O. Essig's 21-page account of "Charles Fuller Baker, Entomologist, Botanist, Teacher, 1872-1927." Baker graduated from Michigan Agricultural College with several hundred boxes of insects. He put in two periods on the staff of Pomona College, Claremont, California where he founded the *Journal of Entomology* in 1909 and the Laguna Marine Laboratory in 1912. Baker's real fame, however, dates from his association with the College of Agriculture of the University of the Philippines in 1912. Here he assembled an insect collection of some 300,000 specimens, which he left to the United States National Museum in Washington, D.C. He was in touch with entomological specialists in all parts of the world and furnished them with material for the description of innumerable new species. Baker died before his time of amoebic dysentery in 1927. His ashes were interred in Japan.

A Laboratory Manual for Life Sciences. HERBERT DRAPKIN. 1959. 129 pp., illus. \$2.40.

General Biology Laboratory Manual. BENSON ELLIS. 1959. 174 pp., illus. \$2.50.

General and Invertebrate Zoology. A Laboratory Manual. BENSON ELLIS. 1959. 250 pp., illus. \$4.00.

Anatomy of the Lower Chordates. JAMES E. CROUCH. 1960. 40 pp., 17 figs. \$1.50.

These are four laboratory manuals that are published by National Press Publications, Palo Alto, California. The first three are for elementary college classes; the last is a somewhat more advanced illustrated description of *Dolichoglossus* (Hemichordata), *Perophora* and *Clavellina* (Urochordata), *Branchiostoma* (Cephalochordata), and the ammocoetes larva of the lamprey.

The Avian Embryo. ALEXIS L. ROMANOFF. 1960. Macmillan, New York. 1305 pp., 426 figs. \$35.00.

This sumptuous volume is the second portion—the first was *The Avian Egg*, 1949—of the author's "lifelong plans to review and assess the entire factual knowledge of avian embryology, including the chemical and pathological aspects." A bibliography of 2700 references—titles are listed only for separate publications—and 441 illustrations consisting of 2256 pen-and-ink drawings reveal something of the book's scope. From the history of the germ cells, through fertilization, early morphogenesis, and the history of the several systems to the matter of extraembryonic membranes the book pursues its careful detailed way patiently citing fact, theory, and diverse interpretations of the developing avian embryo. It will surely occupy an honored place on the embryologists bookshelf for decades to come.

Outline of Human Genetics. L. S. PENROSE. 1959. John Wiley & Sons, New York. 146 pp., illus. \$2.50.

This is a useful summary of the present situation in human genetics. Single gene effects, gene equilibrium in populations, and the few established cases of linkage are discussed. The author, who is in the Galton Laboratory in University College, London, urges a critical view of the relative importance of environment and heredity. He sees no evidence of any general decline in the intelligence and ability of present populations and points out the

difficulties and dangers accompanying proposed programs of eugenics. He suggests (p. 56) that "at least one mutation, on the average, would occur... in the germ cells of each" human individual. He feels that with the continued interbreeding of human populations "the local genetical peculiarities of tribes, clans and so-called racial groups may... become less, ... provided that assortive mating stays, the... race will still contain plenty of divergent types." (p. 123)

Essentials of Healthier Living. A Realistic College Text in Personal and Community Health. JUSTUS J. SCHIFFERES. 1960. John Wiley & Sons, Inc., New York. 335 pp., illus. \$5.50.

This is a widely ranging scientifically based interesting manual of health and personal advice for use in a health and personal hygiene course. It ranges from first aid and infectious diseases to problems of mental health and sex. There is no mention of birth control.

Principals of Nutrition. EVA D. WILSON, KATHERINE H. FISHER, and MARY E. FUQUA. 1959. John Wiley & Sons, Inc., New York. 483 pp., 141 figs. \$5.95.

An interestingly written elementary presentation for college students. The authors have a special delight in breakfast, which they want no one to miss!

Introduction to Foods and Nutrition.

GLADYS T. STEVENSON and CORA MILLER. 1960. John Wiley & Sons, Inc., New York. 517 pp., 114 figs. \$6.25.

This is a very practical introduction to food selection and preparation for classes in home economics. The physiological aspects of the subjects are briefly considered, but the main emphasis is on the everyday matters that concern the housewife-to-be in budgeting, purchasing and setting out her meals. It is not a cookbook, but contains the background information that makes a cookbook most usable.

Waves and the Ear. WILLEM A. VAN BERGEIJK, JOHN R. PIERCE, and EDWARD E. DAVID, JR. 1960. Anchor Books, Doubleday & Co., Inc., Garden City. 235 pp., illus. paper \$0.95.

A high level introduction by two zoologists and a physicist on the origin, propagation, and reception of sound by man with some reference to other animals.

The Microcirculation Symposia on Factors Influencing Exchange of Substances Across Capillary Walls. 1959. Edited by S. R. M. REYNOLDS and BENJAMIN W. ZWEIFACH. University of Illinois Press, Urbana. 170 pp., 72 figs. \$4.50.

A collection of eleven papers and considerable informal discussion given at the Fifth Conference on Microcirculatory Physiology and Pathology, Buffalo, N. Y., April 1, 1958. Accompanied by excellent illustrations, bibliographies, and index.

Wound Healing and Tissue Repair. 1959. Edited by W. BRADFORD PATTERSON. University of Chicago Press, Chicago. 83 pp., 26 figs. \$2.75.

This is a condensed version of the stenographic report of a conference between twenty-five or thirty developmental biologists on the fundamental biological processes involved in tissue regeneration. Among the more extensive contributions may be mentioned reports by P. Weiss, G. H. Algire, K. Meyer, J. Gross, M. B. Williamson, F. D. Moore, S. M. Levenson, and M. R. Urist. No index.

Tools of Biological Research. 1959, edited by HEDLEY J. B. ATKINS. Charles C. Thomas, Springfield, Illinois. 183 pp., illus. \$8.00.

This is a series of ten essays by different authors describing various techniques of biological research of especial interest to medical men. The design of experiments, flame photometry, tissue culture, electron

microscopy, mass spectrometry, and tissue transplantation are some of the topics considered. The book was written and printed in England. A useful reference.

Modern Organization Theory. A Symposium of the Foundation for Research

on Human Behavior. 1959. Edited by MASON HAIRE. John Wiley & Sons, Inc., New York. 324 pp., illus. \$7.75.

Eleven papers, mostly on industrial organization, given at Ann Arbor, Michigan in February 1959.

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DELTA—University of Maine, Orono, Maine, 27 January 1917.

EPSILON—University of Denver, Denver, Colorado, 5 March 1917.

ZETA—University of Wisconsin, Madison, Wisconsin, 30 May 1917.

ETA—University of Akron, Akron, Ohio, 20 April 1921.

THETA—Michigan State College, Lansing, Michigan, 9 April 1921.

IOTA—Washington University, St. Louis, Missouri, 28 May 1921.

KAPPA—University of Kansas, Lawrence, Kansas, 31 May 1921.

LAMBDA—University of Montana, Missoula, Montana, 4 May 1921.

MU—University of California, Berkeley, California, 27 April 1922.

NU—Washington and Jefferson College, Washington, Pennsylvania, 11 May 1922.

XI—University of Nebraska, Lincoln, Nebraska, 3 May 1924.

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PI—Emory University, Georgia, 3 January 1925.

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SIGMA—University of Florida, Gainesville, Florida, 4 December 1925.

TAU—Duke University, Durham, North Carolina, 4 March 1926.

UPSILON—Miami University, Oxford, Ohio, 7 May 1926.

PHI—University of New Hampshire, Durham, New Hampshire, 21 May 1926.

CHI—Montana State College, Bozeman, Montana, 11 February 1927.

PSI—University of Washington, Seattle, Washington, 7 April 1928.

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ALPHA KAPPA—Hunter College, New York City, 8 January 1932.

ALPHA LAMBDA—University of Utah, Salt Lake City, Utah, 13 February 1932.

ALPHA MU—University and State College of Oregon, Eugene-Portland-Corvallis, Oregon, 18 November 1933.

ALPHA NU—University of New Mexico, Albuquerque, New Mexico, 21 April 1935.

ALPHA XI—University of Rhode Island, Kingston, Rhode Island, 17 May 1935.

ALPHA OMICRON—Marquette University, Milwaukee, Wisconsin, 18 June 1938.

ALPHA PI—University of Colorado, Boulder, Colorado, 24 May 1941.

ALPHA RHO—University of Arkansas, Fayetteville, Arkansas, 23 May 1945.

ALPHA SIGMA—University of Texas, Austin, Texas, 2 February 1946.

ALPHA TAU—National University of Mexico, Mexico, D.F., 7 April 1947.

ALPHA UPSILON—University of California at Los Angeles, California, 17 May 1947.

ALPHA PHI—College of Puget Sound, Tacoma, Washington, 28 February 1948.

ALPHA CHI—University of the Philippines, Manila, Luzon, P.I., 12 March 1949.

ALPHA PSI—Virginia Polytechnic Institute, Blacksburg, Virginia, 24 May 1949.

ALPHA OMEGA—University of Georgia, Athens, Georgia, 17 May 1951.

BETA ALPHA—Pennsylvania State Univ., State College, Pennsylvania, 26 May 1955.

BETA BETA—Florida State University, Tallahassee, Florida, 18 February 1956.

BETA GAMMA—Long Island University, Brooklyn N. Y., 27 April 1957.

BETA DELTA—University of Virginia, Charlottesville, Virginia, 22 March 1958.

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